

# TECHNICAL NOTES

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U.S. DEPARTMENT OF AGRICULTURE  
FORESTRY-18 (Revised)  
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NATURAL RESOURCES CONSERVATION SERVICE  
SPOKANE, WASHINGTON  
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## TREE AND SHRUB WINDBREAK EFFECTIVENESS A Field Evaluation Procedure

Purpose: A field evaluation procedure for measuring a tree and/or shrub windbreak's effectiveness on reducing wind velocity provides the framework and method for the constant evaluation of local vegetative wind barriers. It also provides an excellent tool for starting a "systems-approach" training program on wind erosive cropland for new employees.

Background: The cause-and-effect relationship of native trees and shrubs in reducing wind velocities led to the establishment of introduced, vegetative windbreaks through the world. Qualitative studies of their effectiveness to reduce wind velocity no doubt started soon after the forest windbreaks were established in any one region. A limited literature review indicates a few recorded quantitative studies were done as early as 1900 to 1910, some in the 1930's, many in the 1940's and early 1950's, and some additional ones in the 1960 through 1975 period. Evaluation locations during the 1940 to 1950's period appear to concentrate in Russia, and the Midwest and Great Plains states of the United States. No recorded quantitative studies are known to exist for neither eastern Washington nor any area of the "Inland Northwest".

The feasibility or practicability of installing windbreaks as a component of cropland management systems in Washington's Columbia Basin and Plateau is based solely on information developed in the Midwest. Because of the widespread establishment of single-row Lombardy poplar (*Populus nigra* var. *italica*) in this physiographic region over the past 30 years, the need for local studies and evaluation is becoming increasingly apparent. Technical adaptation of non-local data and practices is a common and proven method in developing and improving conservation programs in any geographic area having similar climatic and edaphic situations. However, at some point in time, it becomes a scientific and professional necessity to confirm such adaptations.

Starting the Evaluations: The following pages give information, data collecting procedures, and recording forms to complete a windbreak effectiveness evaluation. The sequence of information is in the order that it should be considered and used. A sample evaluation sheet is the last page of this Technical Note (Attachment #3).

An important aspect of communicating results is providing copies of the evaluation to other interested conservationists, agronomists, and foresters. At a minimum, it is

suggested that field office personnel provide copies of each windbreak evaluation to the area office. Specialists at the area office, in turn, can distribute the information to other conservationists, agronomists, and foresters. The State Staff Forester will be responsible for analyzing and summarizing the evaluations and disseminating the results.

## DETAILED PROCEDURE FOR A TREE/SHRUB WINDBREAK EVALUATION

1. Complete the front side of the evaluation. Refer to Attachment #1 on how to use a clinometer or abney level to determine heights of trees. Attachment #2 illustrates examples of windbreak frontal views (draw what you see!)
2. Locate the approximate center of the uniform windbreak or windbreak segment.
3. Determine the direction that the wind is coming from in degrees Azimuth from true North\* (0 to 360°). Record the direction (and all information from the items below) on the backside of the evaluation.
4. Determine orientation of the windbreak by looking down the row(s) and indicate degrees Azimuth from true North\* (0 to 360°).
5. Stake the first line of measuring points in the direction of the wind at 10H windward of the tallest row of the windbreak and 1H, 3H, 6H, 10H, 15H, and 20H leeward. "H" is the average height of the tallest row in the windbreak. A sample layout diagram is on the back of this page. An optional second line may be staked 100 feet either way of the first line if time is available to replicate the first set of data. Note: field conditions, topography, crop height, or some other facts may limit measurements all the way to 20H leeward; all evaluations should be made to at least 10H leeward.
6. Before positioning people to take readings, it is important to have a predetermined time interval between measurements to allow the leeward person to move from one point to another. For example, the leeward person would take 3 minutes to walk from 10H to 15H if the windbreak is 80 feet tall (a person can walk about 150 feet in one minute under field conditions). Be sure to allow some time for recording the readings.
7. Position the first person at 10H windward on line one with a signaling device (if used), stop watch, anemometer, and a blank evaluation form. Position the second person at 1H leeward on line one with a stop watch, anemometer, and a blank evaluation form.
8. At the signal or prearranged starting time, both persons read the "low" to "high" wind speeds for a 15-second period at the 10H windward and 1H leeward positions. The anemometer is always held out at five feet above the "wind friction surface". The wind friction surface is the top of the average ground line, residues or standing crop, whichever is highest. For example, the windward side of a windbreak is in a fallow condition; the lee side has 8" high alfalfa. The anemometer is held at 5' above the fallow ground on the windward measurement and 5'8" on the leeward measurements. The anemometer will always be held at a 5' to 6' height, depending upon field condition. The anemometer is held at arm's length and with the evaluator's head and

upper body to the leeward or side when taking the reading. Record the readings with the leeward evaluator moving on quickly to the next pre-located point.

9. The leeward person moves to the next position, i.e. 3H, and repeats step 8 at the signal or prearranged time. This is done at 6H, 10H, 15H, and 20H leeward, successively.
  10. If there is a “line 2”, repeat steps 8 and 9.
  11. Compute the average windward and leeward wind speeds and “open field” percentages. Make sure all other portions of the evaluation are complete before leaving the site. Provide one copy to the Area Office.
- \* the compass must have a 20° East declination adjustment.

## PREPARATION FOR A TREE/SHRUB WINDBREAK EVALUATION (For determining wind velocity reduction)

Equipment Needed: Anemometers (revolving cup type), stop watches (or wrist watches that are synchronized), clinometer or abney level, measuring tape (100' cloth or equivalent), and an azimuth compass. Optional equipment can include pocket calculators and walkie-talkies's, whistles, or horns for signaling purposes.

Timing: Measurements taken when steady winds at 5 feet above the ground are 20 or more miles per hour will yield the most usable results. These winds are likely to occur during February through May and September through November. Another consideration is the stage or percentage of "leaf-out" in spring and "leaf-out" in autumn of deciduous species. Evaluations both before bud-break and during full leaf-out are desired.

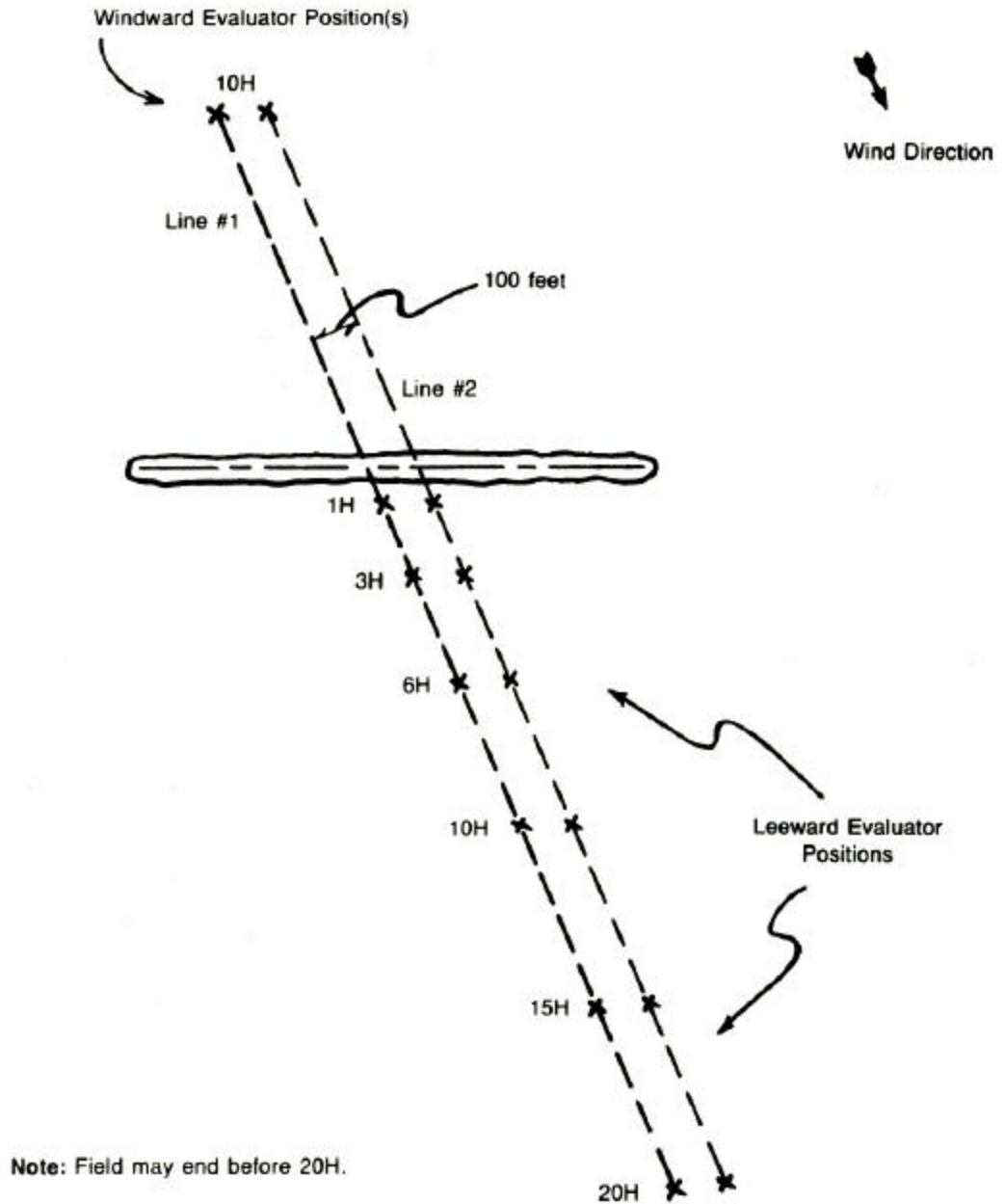
Suitable Windbreak Sites and Conditions: Only evaluate windbreaks or segments of windbreaks with uniform heights and densities. Any other type of windbreak will yield undesirable results.

Acceptable Windward/Leeward Field Crop Conditions: Similar or near-similar crop or field surface conditions on the windward and leeward sides are required. Ideally, fields on both sides of the windbreak should be flat with no standing vegetation.

General Field Procedure (after arriving at the pre-chosen windbreak):

1. Complete the front side of the WINDBREAK FIELD EVALUATION sheet answering all questions. Two blank evaluation sheets are provided after the DETAILED PROCEDURE PAGE. If more are needed, copy the blank sheet or request more copies of Forestry-14 Technical Note from the State Office.
2. Using the backside of the evaluation, complete the required information about wind direction (the top of page will always "face" directly into the wind), windbreak height, wind velocities at the time and durations specified, etc.

## SAMPLE LAYOUT DIAGRAM



\*Line 2 is optional and can be 100 feet right or left of Line 1

**WINDBREAK FIELD EVALUATION**  
(Frontside)

County: \_\_\_\_\_ Evaluators: \_\_\_\_\_ Date: \_\_/\_\_/\_\_

Owner: \_\_\_\_\_ Windbreak Legal Description: \_\_\_\_\_

Windbreak Location Sketch (includes road names, symbols for buildings, field boundaries, etc.):

?N

Windbreak Information:	Species	Spacing Between Tree/Shrubs In Row	Spacing Between Rows	Average Height
Row 1**	_____	_____	_____	_____
Row 2	_____	_____	_____	_____
Row 3	_____	_____	_____	_____
Row 4	_____	_____	_____	_____
Row 5	_____	_____	_____	_____

Deciduous Tree/Shrub Condition: (check one) \_\_\_\_\_ Dormant \_\_\_\_\_ Fully Leafed Out

Windbreak Frontal View Drawing (complete from 1 or 2H windward; see examples):

NOTE: Crop/vegetation on the windward and leeward sides within the measuring zone **must** be less than 12 inches.

\* tallest row is "H"; **transfer** to the backside of the sheet

\*\* Row 1 is always on the windward side

cc: Area Office

## WIND VELOCITY DATA

? Wind Direction is  
From \_\_\_\_\_? Azimuth  
(true North)

Windbreak Average  
Height "H" = \_\_\_\_\_

Windbreak Orientation is \_\_\_\_\_? Azimuth (true North)

\* \* \*

READ AT  
"SIGNAL" or  
PREDETERMINED  
TIME:

RECORD THE "LOW" to "HIGH" WIND SPEEDS FOR  
A 15 SECOND DURATION AT 5 FEET ABOVE THE  
GROUND FOR LINE 1 (use another Field Data sheet if  
there is a "line 2" of data):

For 1H... W* = _____ to _____ L* = _____ to _____	Average = _____ m.p.h. Average = _____ m.p.h.	(L/W)x100 = _____%
For 3H... W* = _____ to _____ L* = _____ to _____	Average = _____ m.p.h. Average = _____ m.p.h.	(L/W)x100 = _____%
For 6H... W* = _____ to _____ L* = _____ to _____	Average = _____ m.p.h. Average = _____ m.p.h.	(L/W)x100 = _____%
For 10H... W* = _____ to _____ L* = _____ to _____	Average = _____ m.p.h. Average = _____ m.p.h.	(L/W)x100 = _____%
For 15H... W* = _____ to _____ L* = _____ to _____	Average = _____ m.p.h. Average = _____ m.p.h.	(L/W)x100 = _____%
For 20H... W* = _____ to _____ L* = _____ to _____	Average = _____ m.p.h. Average = _____ m.p.h.	(L/W)x100 = _____%

\* \* \*

\* "W" = 10H windward position wind speed; "L" = leeward positions wind speeds  
 \*\* "(L/W)x100" = The leeward avg. speed expressed as a percent of open (windward)  
 avg. speed, e.g. 15 m.p.h. leeward divided by 25 m.p.h. windward, times 100 equals 60  
 percent of open field velocity. This is a 40 percent **reduction** (100% minus 60%) in  
 wind velocity.

REMEMBER! – ALL POINTS ARE LAID OUT IN THE DIRECTION OF THE WIND!



Attachment #1

**HEIGHT DETERMINATION OF WINDBREAK TREES  
using a  
CLINOMETER or ABNEY LEVEL**

**Step 1**

Measure out 100 feet **perpendicular** to the direction of the tallest tree row to determine the "H" or average height of the windbreak.

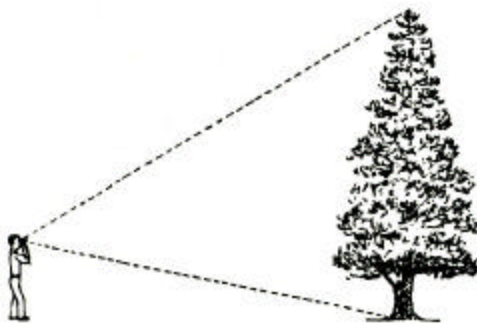
**Step 2**

**Clinometer:** Facing the windbreak hold the instrument up to one eye and, using the **percent** scale, move it up until the horizontal line within matches the average height of tree tops in the tallest row. Both eyes remain open! Observe the scale and jot down the "up" reading. Move the clinometer down to match the horizontal line with the base of the trees (estimate if obscured by another row), observe the scale and list the "down" reading.

**Abney Level:** The same procedure as the clinometer is used except that only one eye remains open and a "bubble" is lined up with the horizontal line for the "up" and "down" readings. The scale is on the outside of the instrument rather than inside.

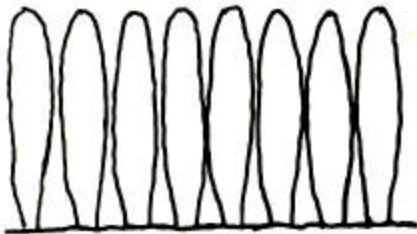
**Step 3**

The "up" readings on a flat field will always be a positive number. The "down" readings may be a positive or negative number. If the "down" reading is negative, the sign is dropped and it is added to the "up" reading. If the "down" reading is positive, it's subtracted from the "up" reading. The result is the average height of the tallest windbreak row.



Attachment #2

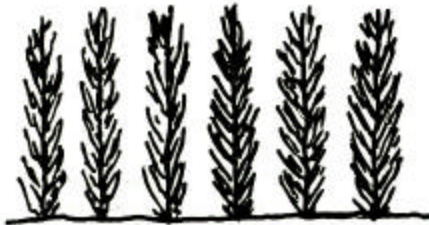
**SAMPLE WINDBREAK FRONTAL VIEW DRAWINGS**



Single-row, columnar type; fully leaf-out; uniform gaps between trees.



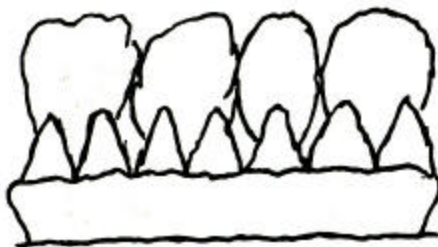
Three-row; windward and leeward rows fully leaf-out; conifers are tallest row.



Same as above except a pre-budbreak condition, i.e. no leaves on trees.



Single-row, columnar type; tight spacing and a pre-budbreak condition.



Same as right-top drawing except deciduous tree row is tallest.



Twin-row of fully leafed-out columnar type with shrub row on windward side; no gaps.

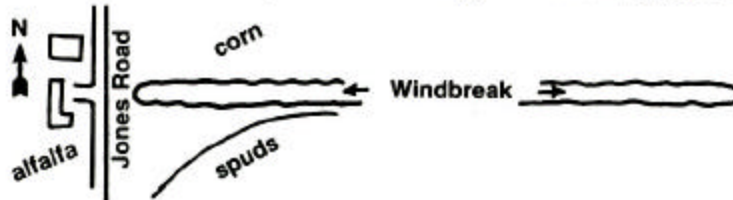
## Attachment #3

# **WINDBREAK FIELD EVALUATION** (frontside)

 County: FRANKLIN Evaluators: R.R. & L.T. Date: 6 / 5 / 84

 Owner: J. JONES Windbreak Legal Description: BLOCK 16

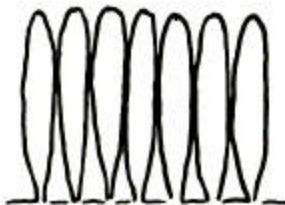
Windbreak Location Sketch (include road names, symbols for buildings, field boundaries, etc.):


**WINDBREAK INFORMATION:**

	Species	Spacing Between Tree/Shrubs in Row	Spacing Between Rows	Average height*
Row 1**	<u>LOMBARDY POPLAR</u>	<u>8'</u>		<u>80'</u>
Row 2				
Row 3				
Row 4				
Row 5				

 Deciduous Tree/Shrub Condition: \_\_\_\_\_ Dormant \_\_\_\_\_ ☒ Fully Leafed-Out  
 (check one)

Windbreak Frontal View Drawing (complete from 1 or 2H windward; see examples):


**NOTE:** Crop/vegetation height on the windward and leeward sides within the measuring zone **must** be less than 12 inches.

\* tallest row is "H"; transfer to the backside of the sheet

\*\* Row 1 is always on the windward side

cc: Area Office

## WIND VELOCITY DATA

Wind Direction is  
from 220 ° Azimuth  
(true North)

Windbreak Average  
Height — "H" = 80'

Windbreak Orientation is 90 ° Azimuth (true North)

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READ AT  
"SIGNAL" or  
PREDETERMINED  
TIME:

RECORD THE "LOW" to "HIGH" WIND SPEEDS FOR A 15 SECOND  
DURATION AT 5 FEET ABOVE THE GROUND FOR LINE 1 (use  
another Field Data sheet if there is a "line 2" of data):

for 1H . . .	W* = <u>21</u> to <u>24</u> L* = <u>8</u> to <u>13</u>	Average = <u>22.5</u> m.p.h. Average = <u>10.5</u> m.p.h.	(L/W)x100 = <u>47</u> %*
for 3H . . .	W = <u>20</u> to <u>25</u> L = <u>6</u> to <u>11</u>	Average = <u>22.5</u> m.p.h. Average = <u>8.5</u> m.p.h.	(L/W)x100 = <u>38</u> %
for 6H . . .	W = <u>20</u> to <u>23</u> L = <u>7</u> to <u>11</u>	Average = <u>21.5</u> m.p.h. Average = <u>9</u> m.p.h.	(L/W)x100 = <u>42</u> %
for 10H . . .	W = <u>20</u> to <u>30</u> L = <u>11</u> to <u>17</u>	Average = <u>25</u> m.p.h. Average = <u>14</u> m.p.h.	(L/W)x100 = <u>56</u> %
for 15H . . .	W = <u>20</u> to <u>25</u> L = <u>13</u> to <u>23</u>	Average = <u>22.5</u> m.p.h. Average = <u>18</u> m.p.h.	(L/W)x100 = <u>80</u> %
for 20H . . .	W = <u>19</u> to <u>25</u> L = <u>17</u> to <u>25</u>	Average = <u>22</u> m.p.h. Average = <u>21</u> m.p.h.	(L/W)x100 = <u>95</u> %

★ ★ ★

\* "W" = 10H windward position wind speed; "L" = leeward positions wind speeds

\*\* "(L/W)x100" = the leeward avg. speed expressed as a percent of open (windward) avg. speed, e.g.  
15 m.p.h. leeward divided by 25 m.p.h. windward, times 100 equals 60 percent of  
open field velocity. This is a 40 percent **reduction** (100% minus 60%) in wind velocity.

**REMEMBER! — All points are laid out in the direction of the wind!**